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Nuts and Bolts of Computing the Ephemeris

Part Two

Jeff Beish,

Association of Lunar and Planetary Observers (A.L.P.O.)

INTRODUCTION

We covered methods to calculate the ***Leap Day, Day of the Year, Day of the Week,*** and the ***Julian Day*** in Part one and will continue with our routines and discussions in ***Local Standard Time (time), Coordinated Universal Time (UTC),*** and ***Local Sidereal Time (LST).***

Some Interesting Web Sites

World Time Zones:

http://www.worldtimezone.com/

Another World Time Zones website can be found at:

http://time.greenwich2000.com/info/timezone.htm

Time Zones in the USA

Time zones are measured from the 0 degrees meridian, somewhere in England, and increases one hour for each 15 degrees of longitude around Earth. This is a general rule. Governments in the various countries attempt to define nature and make laws governing how our clocks will show time. After looking at a colored map onthe World Time Zones web page it is easy to see that times zones really follow more closely to country boundaries than to the 15-degree longitude zones.

For time calculations we define the times zones in the United States are as follows: Eastern (5), Central (6), Mountain (7), Pacific (8), Alaska (9), and Hawaii (10).

Daylight Savings Time

Here is a function of time that is as unnatural as anything astronomers can use. Daylight Savings Time (DST) is purely a government operation and is set by law to change the clock in certain locations around the world. We either "spring forward" one hour (even a halfhour in some countries) on a day in springtime and "fall back" an hour during a day in autumn.

Some like to call Daylight Savings Time, "summertime." Daylight saving time began in the United States during World War I, primarily to save fuel by reducing the need to use artificial lighting but only became a nation ritual during World War II.

In the USA all states but Arizona, Hawaii, the eastern zone portion of Indiana, Puerto Rico, the U.S. Virgin Islands and American Samoa practice this unnatural act. That is, change over to DST, during the early hours (2 a.m.) of the first Sunday of April and revert back to Standard Time during the early hours (2 a.m.) of the last Sunday in October. Funny, if you followed the letter of the law you would get up at 2 a.m. the last Sunday morning of the year. Set your clock back an hour – to 1 a.m. then wait until the clock read 2 a.m. and then set your clock back an hour -- AGAIN! This could conceivably go on until you reached the first Sunday in April then go on for there. Just kidding..... But, it gives some indication of how government works!

The Daylight Saving Time Zones for the USA are Eastern (4), Central (5), Mountain (6), Pacific (7) and for Arizona (5), Hawaii (10), the eastern time zone portion of Indiana (6), Puerto Rico (4), the U.S. Virgin Islands (4), and American Samoa (11).

For local civil time, VB format is Format(UT, "hh:nn" AM/PM)

Coordinated Universal Time

Coordinated Universal Time (UTC) is a system we astronomers use. Also, times for us are usually converted to 24-hour time, i.e., 1 a.m. is 0100 hours, 1 p.m. is 1300 hours and so on. Mid-night or 12 a.m. is 0000 hours, not 2400. To find the UTC for your time zone, simply add the Time Zone values (negative for us), mentioned above, in Time Zones in the USA to your local 24-hour time and if it goes over 24 hours then subtract 24 from that.

Example 1: April 04, 1999, at Eastern Standard Time 3 a.m. the Universal Time (UT) would be:

Find: 24-hour clock for EST 3: 30a.m. = 0330. (Note that we have already passed the Daylight Savings at 2 a.m. this day! So, time zone will be 4 hours instead of 5 hours)

Find: UT for 0330 in the Eastern Time Zone add 5 hours

UT = 0330 +0500 = 0830

Format(UT, "hh:nn") = 03:30

Example 2: November 30, 1999, at 9 p.m. or 2100 hours.

Find: UT for 2100 in the Eastern Time Zone add 5 hours;

UT = 2100 + 0500 = 2600. Normalize by subtracting 2400

UT = 2600 - 2400 = 0200

Format(UT, "hh:nn:ss") = 02:00:00

There are several sources for setting your astronomical clocks. Since this author works for the U.S. Naval Observatory it is recommended that observers call into 1-202-762-1594 if you have a computer time setting program such as TimeSet (DOS) or Atomic.exe (Atomic Clock for Windows) and so on. You can find Timeset on the Rightime web page (http://www.rightime.com/) or the Atomic Clock at Parsons Technology (1-800-223-6925).

Reference: Systems of Time, http://tycho.usno.navy.mil/systime.html

Converting from Universal Time, http://tycho.usno.navy.mil/zones.html

Local Sidereal Time

Routine 1: Find: Greenwich Sidereal Time (GST)
Reference: Local Apparent Sidereal Time: http://tycho.usno.navy.mil/sidereal.html

GST = 6.6460656 + 2400.0512617 * (JulianDate- 2415020) / 36525+ 1.002737908 * UT

Find: Local Sidereal Time (Lst) = GST + Longitude / 15

Example 1: Lmt for March 11, 1999 at 11:30 a.m. at longitude 77:18:41

Convert longitude to decimal: 77 + 18/60 + 41/3600 = 77.311389
Since the longitude is to the west it is negative (-): longitude = - 77.311389.

Find UT for 11:30 a.m.: UT = 1130 + 5 = 1630 or 16.5 hours

Calculate JulianDate (JD) at 0h UT: JD = 2451248.5

Find: GST = 6.6460656 + 2400.0512617 (JulianDate- 2415020) / 36525 + 1.002737908 * 16.5
= 6.6460656 + 2380.56829937025 + 16.545175482
= 2403.75954045225

Normalize GST < 24 hours:

GST = 2403.75954045225 / 24
= 99.4672652070938

GST = 24 * (99.4672652070938- Int(99.4672652070938))
= 3.75954045225183

Correct for longitude:

Lst = GST + Longitude / 15
= 3.75954045225183 + (- 77.311389 / 15)
= -1.39455214774817

Normalize Lst

If Lst< 0 then Lst = Lst + 24
Lst = Lst + 24
= 22.6054478596592

Convert Lst to Hours, minutes, and seconds: 22.6054478596592 = 22 : 36 : 19

****

Routine 2: Find: Greenwich Sidereal Time (GST)
Reference: **Astronomical Algorithms**, Jean Meeus , page 83 –85:

JulianDate = 2451248.5 + 16.5 / 24 = 2451249.1875

T = (JulianDate – 2451545) / 36525

Find GST in degrees:

GST = 280.46061837 + 360.98564736629 * (JulianDate– 2451545) + 0.000387933 * T^2 - T^3 / 38710000
= -106503.606193145

Normalize GST < 360 Degrees:

GST = -106503.606193145 / 360 = 0.156649463485508
GST = 360 * (GST - Int(GST))
= 360 * (0.156649463485508– Int(0.156649463485508))
= 56.3938068547827

Correct for longitude:

Lst = GST - 77.311389
= -20.9175821452173

Convert to hours:

Lst = Lst / 15
= -20.9175821452173 / 15

= -1.39450547634782

Normalize Lst

If Lst< 0 then Lst = Lst + 24
Lst = Lst + 24
= 22.6054945236522

Convert Lst to Hours, minutes, and seconds: 22.6054945236522= 22 : 36 : 19

Reference: Compute Local Apparent: Sidereal Time:
http://tycho.usno.navy.mil/sidereal.html

Click Here to Go Back to The Digital Lens